Final Design Report

BESSRC CAT
12-BM

October 1995

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Introduction

The Preliminary Design Report (PDR) for the BESSRC CAT sectors at the Advanced Photon Source (APS) provided the information about the scientific programs at all the BESSRC beamlines and detailed drawings of the beamlines layouts. Whereas the PDR covered all the BESSRC beamlines in one document, the Final Design Report (FDR) for the BESSRC sectors will be done one beamline at a time (i.e. 12-BM, 12-ID, and 11-ID each separately). We have included sections of the PDR in some cases to clarify details of the beamline. In general the sections of the PDR which are unchanged will be summarized or referenced as part of the FDR.

Future plans for this beamline call for the addition of a mirror to be used for focusing the monochromatic beam. This mirror will also allow pink light operation of the beamline for Laue diffraction experiments. The FDR for the 12-BM beamline includes the requirements for the Personnel Safety System (PSS) and Equipment Protection System (EPS) for both monochromatic and Pink Light operation of the 12-BM Experimental Stations.

Scientific Programs

The 12-BM beamline is a general purpose beamline for spectroscopy and x-ray diffraction. Details of the scientific program in these areas are found in the 12-BM section of the PDR and are also contained in the Basic Energy Sciences Synchrotron Radiation Center (BESSRC) Collaborative Access Team (CAT) Proposal.

Beamline Layout

Beamline Description

The 12-BM beamline is shown in Figure 1. The beamline has two enclosures; a white-beam first optics enclosure (FOE), 12-BM-A; and 12-BM-B, a pink light shielded

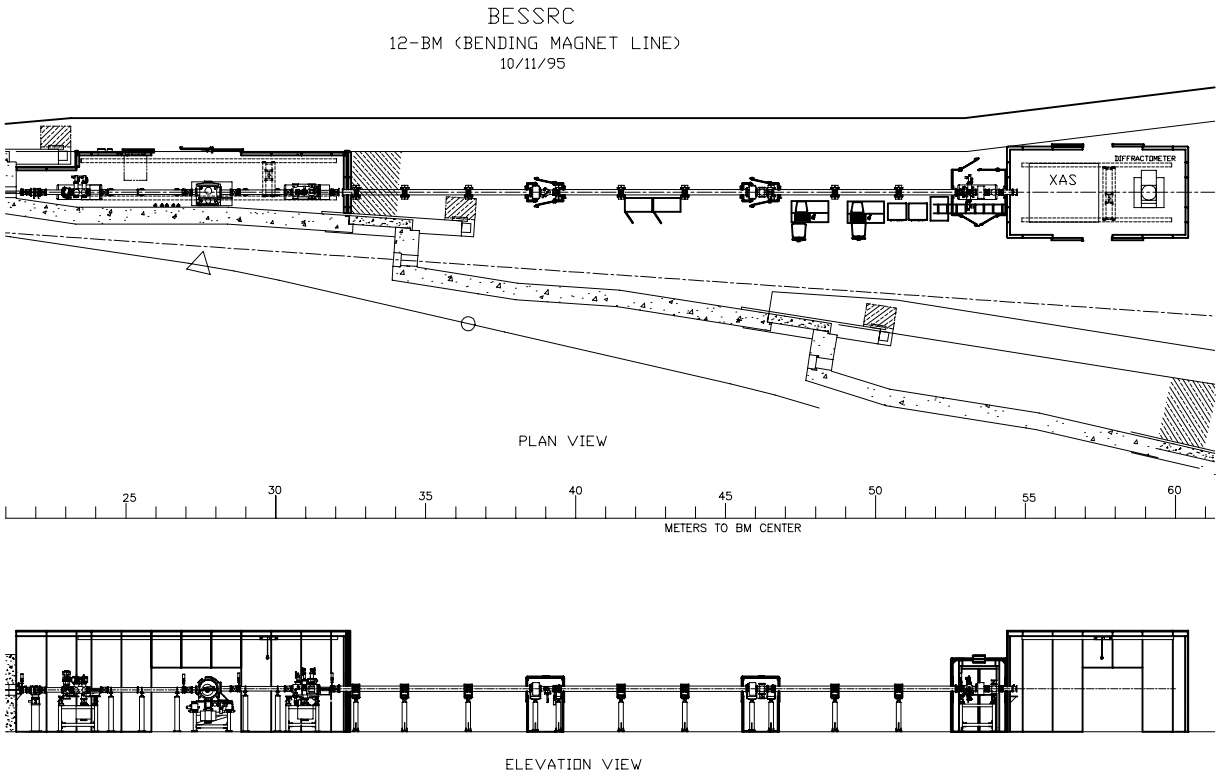

Figure 1. Plan and elevation views of the 12-BM beamline.

Table 1 BM Beamline Components and Location

Component	Part #	Location (m)
Center of Bending Magnet	APS	0.0
Wall Penetration	APS	21.35
Be Window	APS	21.84
Table for Filters and Slits	T-5-21	
White Light Filters	F2-20 Filter Assembly	22.88
White Light Slits	L3-20 Slit Assembly	23.18
Collimator	K2	23.78
Monochromator	BESSRC Std. Mono	27.35
Table for Shutter	T5-22	
White Light Shutter and Back Stop	P6-20 Shutter and Back Stop Assembly	30.53
Collimator	K2	31.45
Table for Slit Assembly	T5-24	
Monochromatic Slit Assembly	L4-20	52.88
Beam Profile Monitor	B5-20S	53.79
Be Window	W4-20S	54.57

experimental station. In addition to these enclosures there are three shielded cabinets along the transport section of the beamline. Shielding for pink radiation is to allow the future addition of a mirror to the beamline. Table 1 lists the beamline components and distances from the center of the bending magnet. A detailed description of the individual components can be found in the appropriate APS documents or in the BESSRC CAT PDR.

The FOE (12-BM-A) contains all the white light components, white light Be window, Filters, Slits and the BESSRC Standard Monochromator. The Shutter for this beamline, a P6-20 (an APS standard component) is designed for white light operation. The intended use of this component is not for white light operation however, but to allow the future addition of a focusing mirror to the beamline. Usage of this component in initial phases of operation will be that of a monochromatic shutter / white beam stop.

The 12-BM-B experimental station is a monochromatic (pink) shielded end station. The initial experimental equipment in the 12-BM experimental station includes a Huber Psi 8-circle goniometer and a table equipped for spectroscopy experiments. The tables for these instruments are being designed to allow the sharing of equipment among the BESSRC experimental stations.

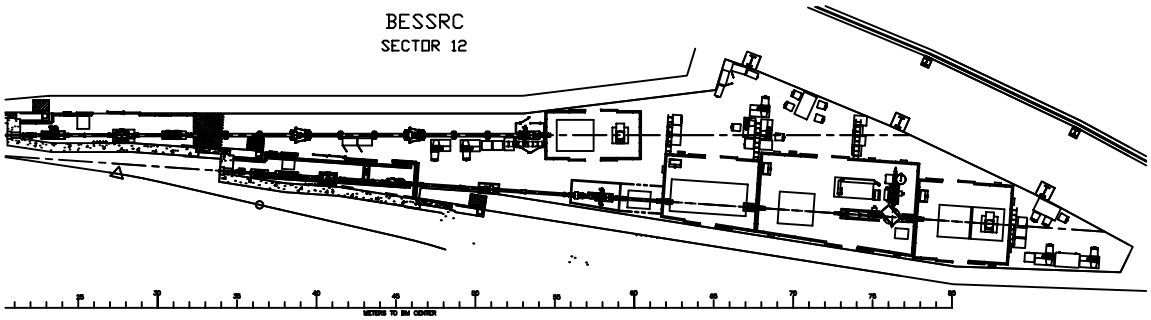

Figure 2 Top view of bending magnet and insertion device beamlines on sector 12.

Beamline Drawings

Detailed drawings of the 12-BM beamline are included. Appendix A contains the complete drawing list that corresponds to each figure in the FDR. In most cases, these drawings include the top and side views of the figure, hutch drawings and also drawings of all non-standard components. Figure 2 is a reduced version of a drawing showing the sector 12 layout. Both BM and ID beamlines are shown. Although this FDR deals only with the 12-BM line, the outline of the 12-ID line is included to show personnel access to the BM beamline hutches and any possible interferences between the two beamlines.

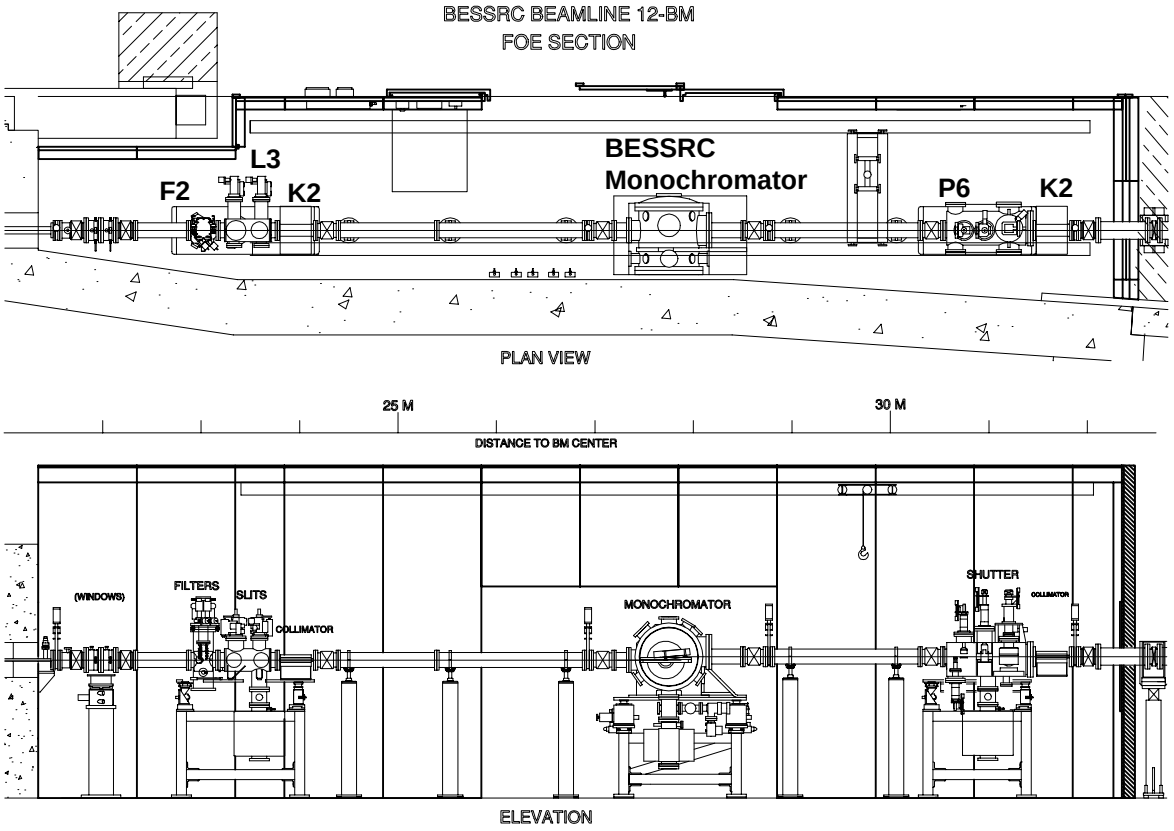

Figure 3. Top and side views of 12-BM-A (FOE). Major components are noted in the top view.

Figure 3 shows the 12-BM-A enclosure (FOE) with components labeled. The complete set of drawings which correspond to this figure includes the 12-BM-A hutch drawing, the top and side views of the assembled beamline and drawings of the BESSRC monochromator chamber and the monochromator table.

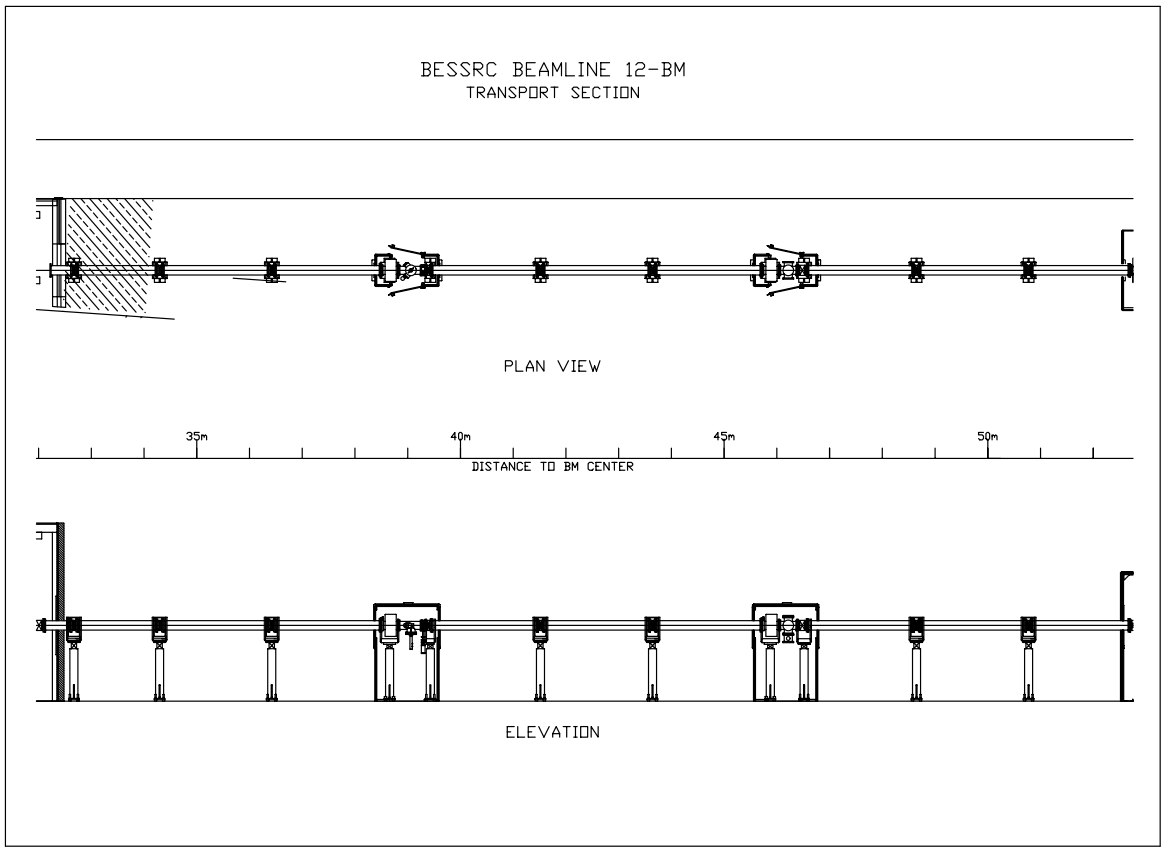

Figure 4 Transport section of the 12-BM beamline.

The transport section between the 12-BM-A enclosure and the 12-BM-B enclosure is shown in Figure 4, the complete drawing set for this figure includes top and side views of the beamline. The small enclosures which shield the ion pumps, beam diagnostic stations, gate valves and bellows are APS standard component so that detailed drawings can be found on the APS design exchange. Figure 5 shows the 12-BM-B hutch along with the instrument cabinet directly upstream form the enclosure.

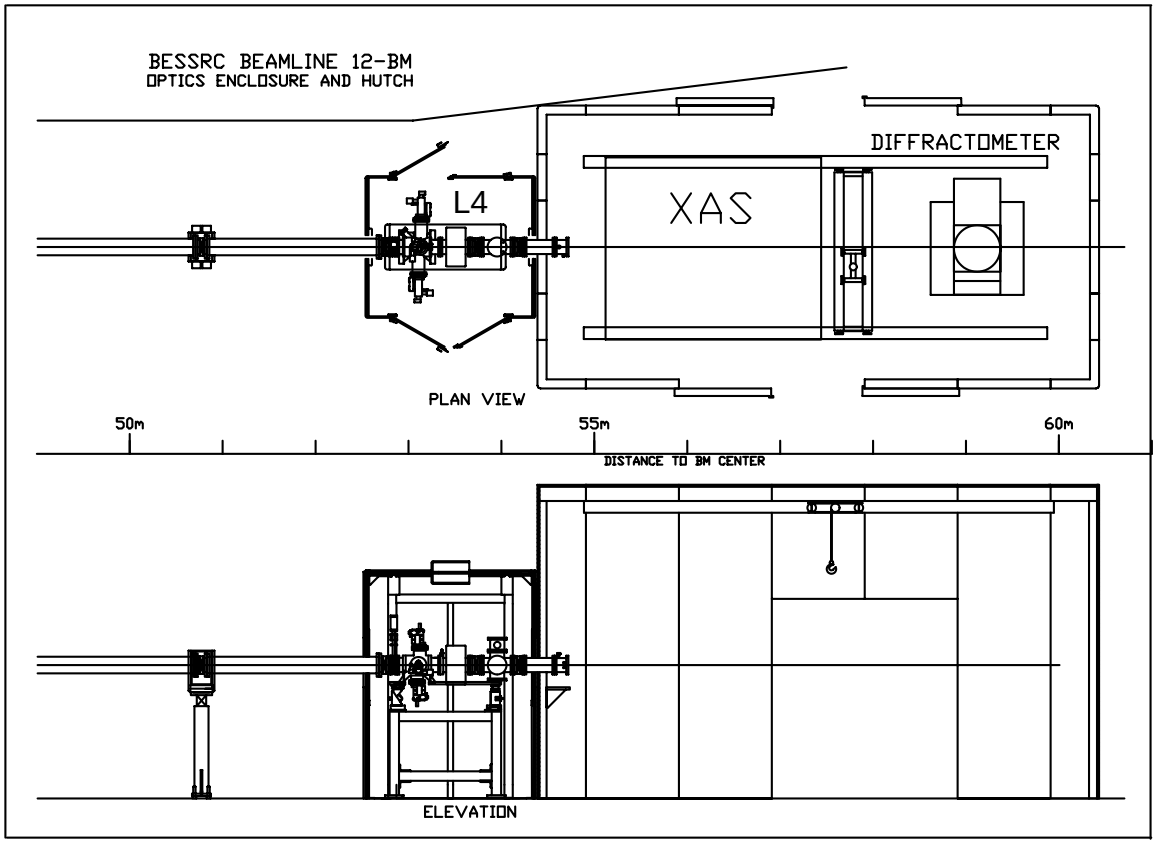

Figure 5 Plan and elevation views of the 12-BM-B experimental hutch.

Changes from PDR

Some changes have been made to the 12-BM beamline layout from the drawings presented in the PDR. These include; small shifts of the standard components in the FOE and the addition of small enclosures along the transport section. Appendix B gives a listing of all the components and their placement along the beamline.

Survey and Alignment Plan

Following the designations used by the SRI CAT in their FDR, critical components define the white beam while non-critical components are not beam defining or are monochromatic components. Components such as monochromators, mirrors and equipment inside the experimental hutches are considered experimental components. The beamline components which are considered critical with respect to survey and alignment are the F2-20 Filter and L3-20 Slits assemblies. The non-critical components in the 12-BM beamline include the

P6-20 Shutter / Stop, L4-20 Monochromatic Slit assembly, beam position monitor and W4-20 Be window. Table 2 contains a complete listing of the components along with the required level of survey and alignment which will be required.

Alignment Procedure for Critical Components

The alignment of Critical Beamline Components will be done in conjunction with the APS/XFD engineering group and APS survey group using alignment procedures which they have established.

Alignment Procedure for Non-Critical Components

The alignment of Non-Critical Beamline Components will be done by BESSRC CAT personnel. For the P6-20 Shutter / Stop, L4-20 Monochromatic Slit assembly, and beam position monitor assistance from the APS/XFD engineering group will be necessary. The procedure to be used for these components follows that given in the SRI CAT FDR. The assistance of the APS/XFD engineering group will be required to determine positions of the centerline for these components relative to fiducials attached to the component. BESSRC CAT personnel will then use normal measurements (level, plumb bob and rules) to locate these components on the beam centerline.

Alignment Procedure for Experimental Components

The alignment of experimental components including the monochromator and equipment in the experimental hutch will be done using the equipment described above. Fine alignment of these components will be done during beamline commissioning using x-rays.

Table 2 Survey and Alignment of Components and survey level

BESSRC Part#	Description	Critical	Non-Critical	Exper.	Alignment done by
12BM11	Front End Be Window	X			APS
12BM12	F.E. Welded Bellows		X		APS
12BM14	Unshielded 6" Pipe		X		BESSRC
12BM17	T5-21 Table		X		BESSRC/APS
12BM18	F2-20 Filter	X			APS
12BM19	L3-20 Slits	X			APS
12BM22	Collimator		X		Connected to adjacent components
12BM23	Formed Bellows		X		Connected to adjacent components
12BM24	Transport Pipe		X		BESSRC
12BM25	Support Stand		X		BESSRC
12BM26	Transport Pipe		X		BESSRC
12BM27	Support Stand		X		BESSRC
12BM28	Support Stand		X		BESSRC
12BM39	Gate Valve		X		Connected to adjacent components
12BM30	Formed Bellows		X		Connected to adjacent components
12BM33	BESSRC Mono Table		X		BESSRC
12BM34	Adapter Pipe		X		Connected to adjacent components
12BM35	BESSRC Mono			X	BESSRC
12BM40	Adapter Pipe		X		Connected to adjacent components
12BM41	Formed Bellows		X		Connected to adjacent components
12BM42	Gate Valve		X		Connected to adjacent components
12BM43	Transport Pipe		X		BESSRC
12BM44	Support Stand		X		Aligns Pipe
12BM45	Support Stand		X		Aligns Pipe
12BM46	Formed Bellows		X		Connected to adjacent components
12BM49	T5-22 Table	X			APS
12BM50	P6-20 Shutter	X			APS
12BM54	Collimator		X		Connected to adjacent components
12BM55	Gate Valve		X		Connected to adjacent components

Table 2 Survey and Alignment of Components and Survey Level (continued)

BESSRC Part#	Description	Critical	Non-Critical	Expire.	Alignment done by
12BM56	V2-91 Welded Bellows		X		Connected to adjacent components
12BM57	Shielded Transport Pipe		X		BESSRC
12BM58	Support Bracket		X		Aligns Pipe
	FOE Wall				Aligns to Pipe
12BM62	U1-57 Welded Bellows		X		BESSRC
12BM63	U1 11" Shielded Support Stand		X		Aligns Pipe
12BM64	Shielded Transport Pipe		X		BESSRC
12BM65	U1-57 Welded Bellows		X		BESSRC
12BM66	U1 11" Shielded Support Stand		X		Aligns Pipe
12BM67	Shielded Transport Pipe		X		BESSRC
12BM68	U1-57 Welded Bellows		X		BESSRC
12BM69	U1 11" Shielded Support Stand		X		Aligns Pipe
12BM70	Shielded Transport Pipe		X		BESSRC
12BM73	U6-70 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM74	Adapter Flange		X		Connected to Beam Pipe
12BM75	In-Line Pump, 120 l/s		X		BESSRC
12BM76	22"x6"x7" Pump Stand		X		Aligns Pump
12BM77	G1-81 Screen Assembly		X		Connected to Pump
12BM78	Gate Valve		X		Connected to adjacent components
12BM79	U1-56 Welded Bellows		X		Connected to adjacent components
12BM80	U1 11" Support Stand		X		Aligns Pipe
12BM81	Shielded Transport Pipe		X		BESSRC
12BM85	U1-57 Welded Bellows		X		BESSRC
12BM86	U1 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM87	Shielded Transport Pipe		X		BESSRC
12BM88	U1-57 Welded Bellows		X		BESSRC
12BM89	U1 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM90	Shielded Transport Pipe		X		BESSRC
12BM93	U6-70 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM94	Adapter Flange		X		Connected to Beam Pipe
12BM95	In-Line Pump, 120 l/s		X		BESSRC
12BM96	22"x6"x7" Pump Stand		X		Aligns Pump
12BM97	6-Way Cross		X		Connected to Beam Pipe

Table 2 Survey and Alignment of Components and Survey Level (continued)

BESSRC Part#	Description	Critical	Non-Critical	Exper.	Alignment done by
12BM99	V2-91 Welded Bellows		X		Connected to adjacent components
12BM100	U1 11" Support Stand		X		Aligns Pipe
12BM101	Shielded Transport Pipe		X		BESSRC
12BM105	U1-57 Welded Bellows		X		BESSRC
12BM106	U1 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM107	Shielded Transport Pipe		X		BESSRC
12BM108	U1-57 Welded Bellows		X		BESSRC
12BM109	U1 6" Shielded Transport Enclosure		X		Aligns to Pipe
12BM110	Shielded Transport Pipe		X		BESSRC
12BM113	U6-30 Enclosure		X		Aligns to Pipe
12BM114	U1-56 Welded Bellows		X		Connected to adjacent components
12BM115	T5-24 Table for L4-20 Slits and Ion Pump		X		BESSRC
12BM116	Gate Valve		X		Connected to adjacent components
12BM117	L4-20 Slits		X		BESSRC
12BM118	In-Line Pump, 120 l/s		X		BESSRC
12BM119	U1-56M Welded Bellows		X		Connected to adjacent components
12BM120	Beam Profile Monitor 6-way Cross		X		BESSRC
12BM122	U1-56M Welded Bellows		X		Connected to adjacent components
12BM123	6" Transport Pipe		X		BESSRC
12BM127	12BM-B Hutch		X		Aligns to Pipe
12BM128	Support Shelf for Be Window		X		BESSRC
12BM129	W4-20 Be Window		X		BESSRC
	EXAFS Table and Instrumentation			X	Aligns to Experimental Beam
	Huber Diffractometer (PSI) and Table			X	Aligns to Experimental Beam

Utilities

Figure 6 shows the utilities distribution plan from the mechanical mezzanine along the 12-ID beamline to the 12-BM transport section and finally on to the 12-BM experimental hutch and FOE. The cable trays for the utilities are suspended over the 12-

BM beamline from pillars just outside the components. This design minimizes the floor space occupied by the beamline.

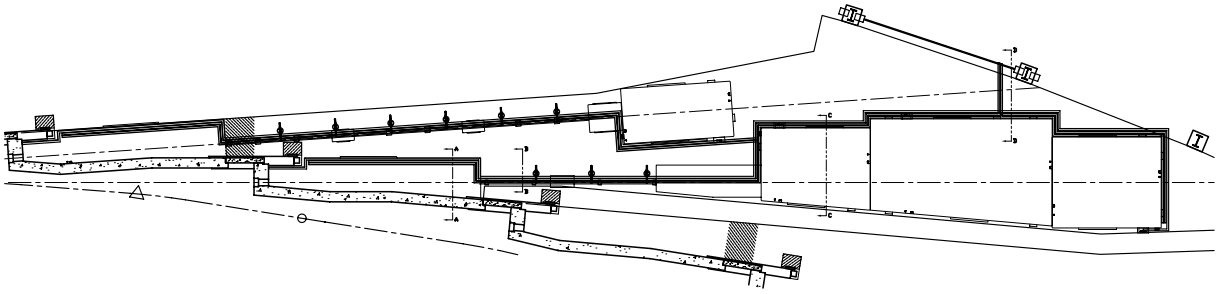

Figure 6. Utility layout for Sector 12. Top view of the cable tray layout for both the Bending Magnet and Insertion Device beamlines is shown.

Chilled Water

Chilled water will be distributed in 2" O.D. stainless steel tubing at the supply pressure. Inside the experimental stations the chilled water will be distributed in 1" O.D. stainless steel tubing. Taps for chilled water will be available in the 12-BM-B enclosure and near the FOE components which require cooling, i.e. the slits, monochromator, and P6 shutter.

Deionized Water

DI (deionized) water is required for all components using copper mesh. For the 12-BM beamline the only component which will require DI water is the P6-20 Shutter/Stop. The P6-20 shutter/stop requires a flow rate of 2.0 gpm and produces a pressure drop of 30 psig. These requirements are easily met by a standalone recirculating chiller which has an ion-exchange cartridge and filter in the cooling loop. This unit will be located in the FOE adjacent to the P6-20 table.

Electrical

The power requirements of the Experimental stations on the 12-BM beamline are noted on the Hutch drawings given in Figures 3 and 5. Of the 30 kVA of utility power and

30 kVA of clean power available for the 12-BM beamline the FOE (12-BM-A) will receive a maximum of 15 kVA of utility power and 10 kVA of clean power. The remainder of the power allocated to 12-BM will be used for the 12-BM-B enclosure and for outlets distributed along the beamline. The locations of the outlets distributed along the beamline are noted on the utilities drawings (Fig. 6).

Compressed Air

Compressed Air will be distributed along the beamline with 1/2" O.D. soldered Cu tubing. Hookups will be available at the ends of the experimental stations and at drops along the length of the transport section (see Fig. 6).

Ray tracing

Ray tracing for the 12-BM beamline is given in Figure 7. Only minor changes have been made to the beamline design since the BESSRC PDR so that the ray tracings from that document are nearly identical to Fig 7. Figure 7C and 7D however shows the beamline ray tracing with the addition of a white light mirror before the monochromator which was not discussed in the PDR . These drawings show that the beamline configuration given in figures 3-5 will also block bremstralung radiation for pink beam operation.

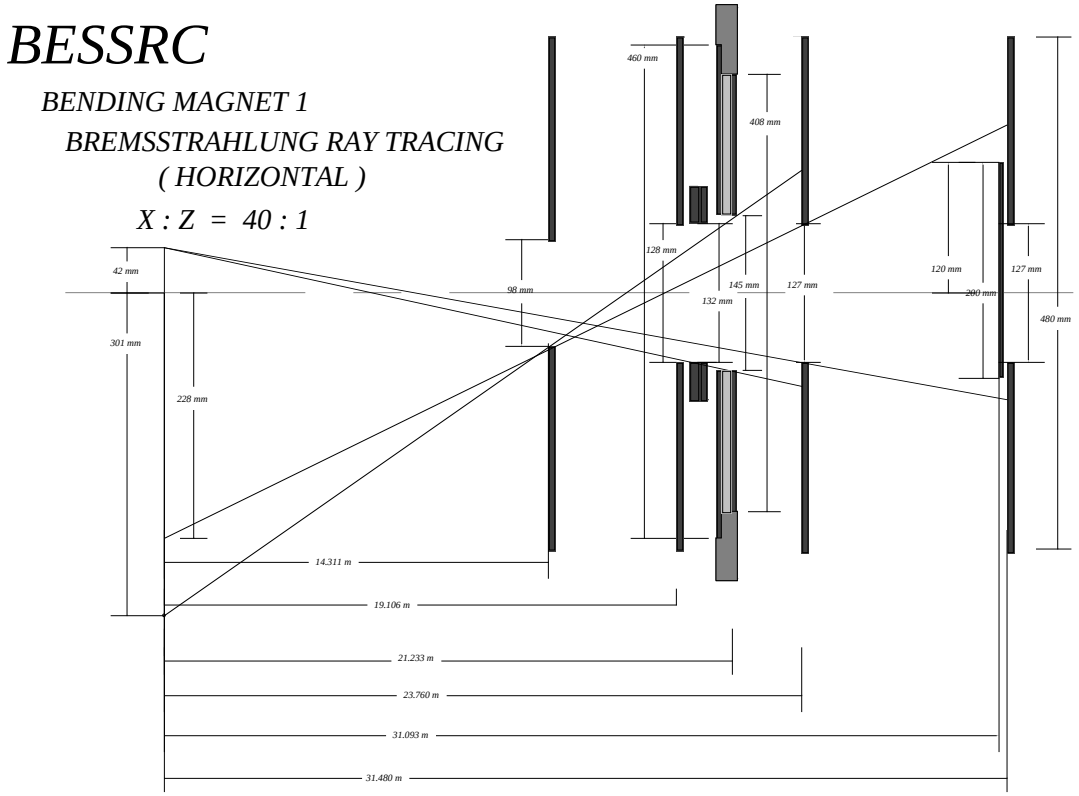

Figure 7A Horizontal Ray tracing for the 12-BM beamline reflecting the final component positions along the beamline.

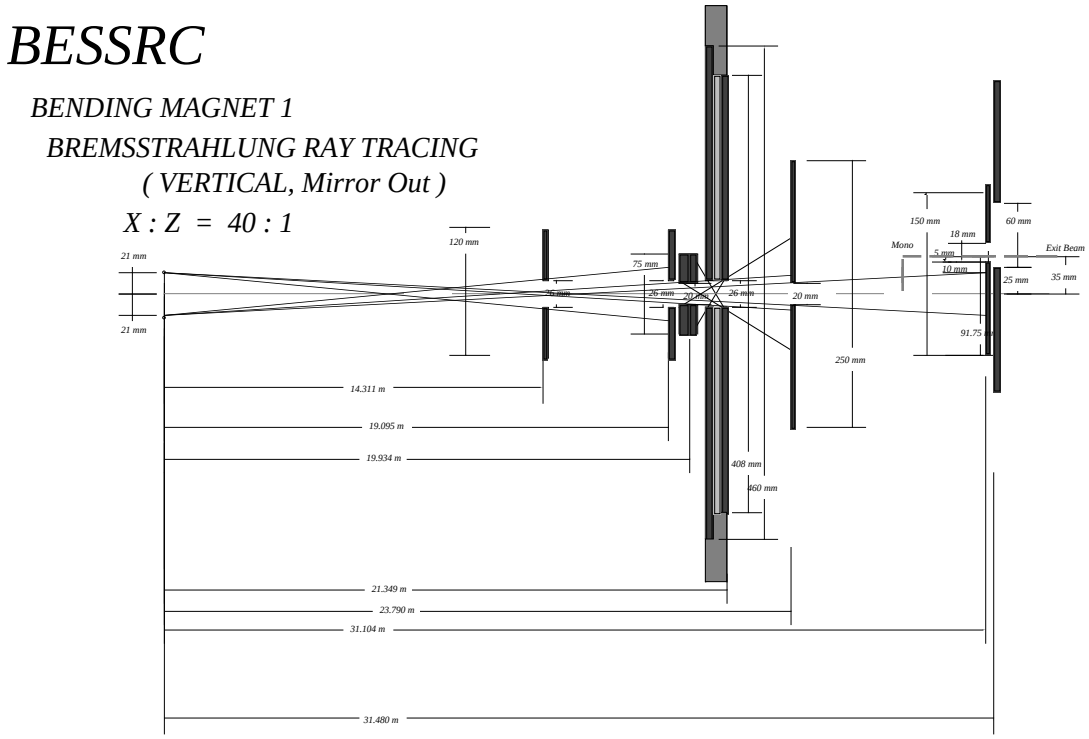

Figure 7B Vertical Ray tracing for the 12-BM beamline.

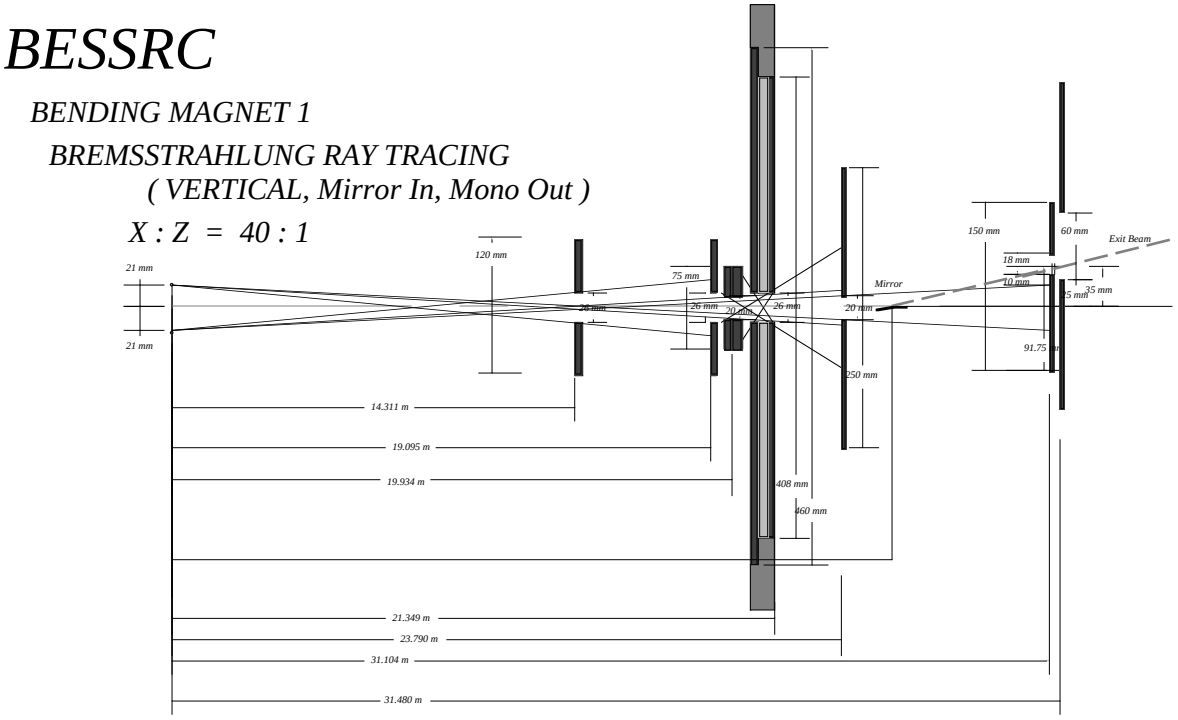

Figure 7C Vertical Ray tracing with only a mirror for pink beam operation.

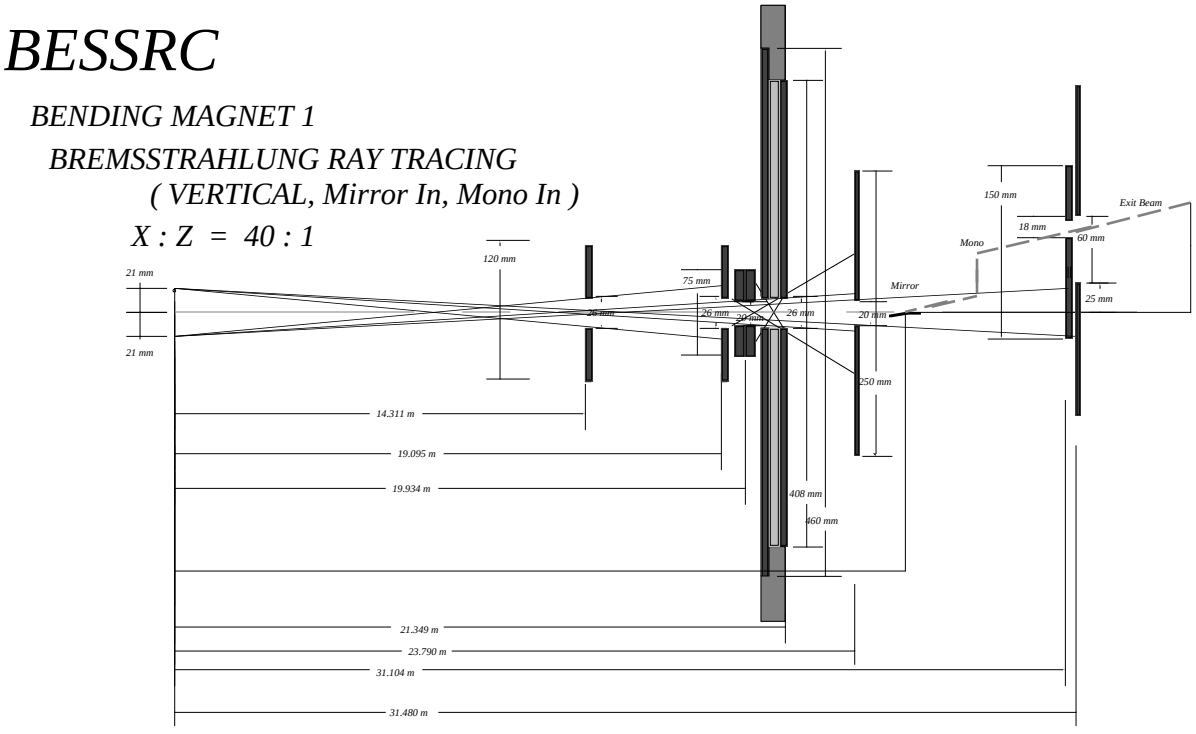

Figure 7D Vertical Ray tracing with both a mirror and monochromator in the beamline.

Beamline Design

Component Assemblies

Appendix B gives a complete listing of all the components on the 12-BM beamline. Since all components except the BESSRC Monochromator are APS standard components assembly drawings are not included for these components. Drawings of the monochromator chamber and monochromator support table are given in Figures 8 and 9.

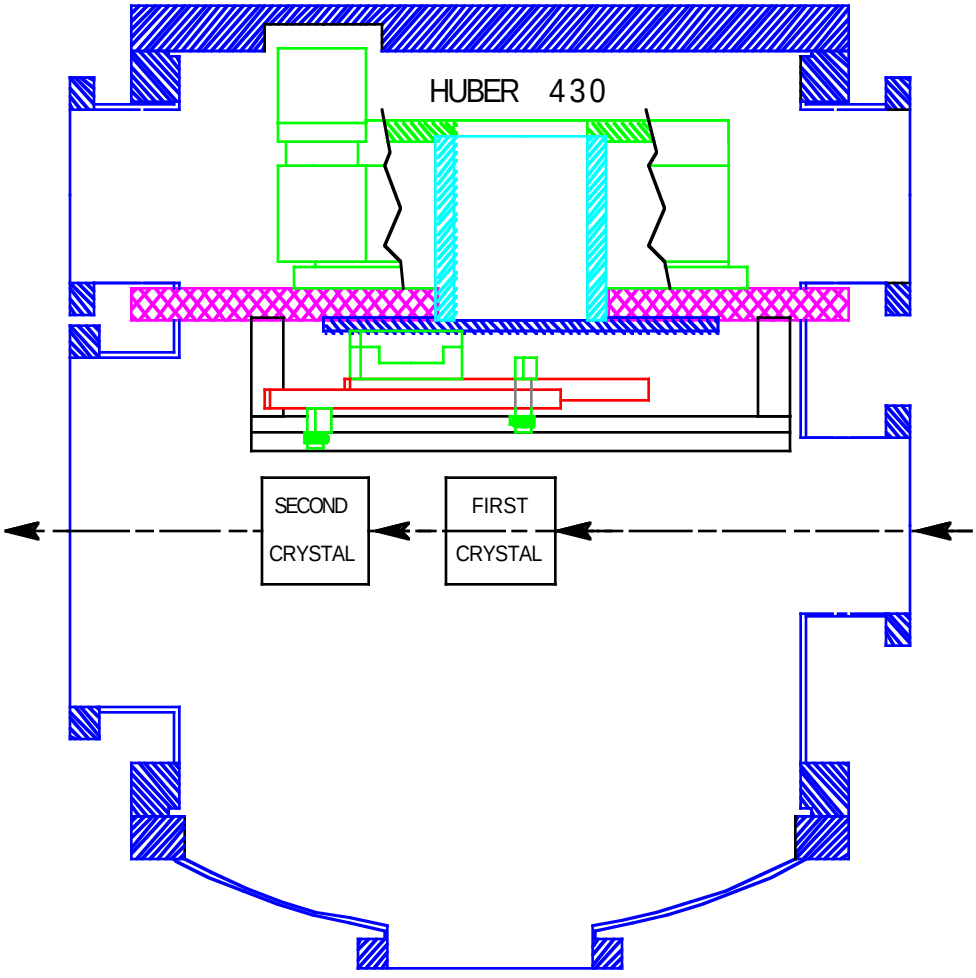

Figure 8 Top view of the BESSRC monochromator chamber. The chamber closest to the wall (at the top of the figure) contains the rotary table which drives the first crystal rotation. The larger chamber (bottom of the figure) contains the monochromator linkage mechanism, crystal mounts and crystals. This arrangement allows easy access to the crystals without disturbing the monochromator alignment.

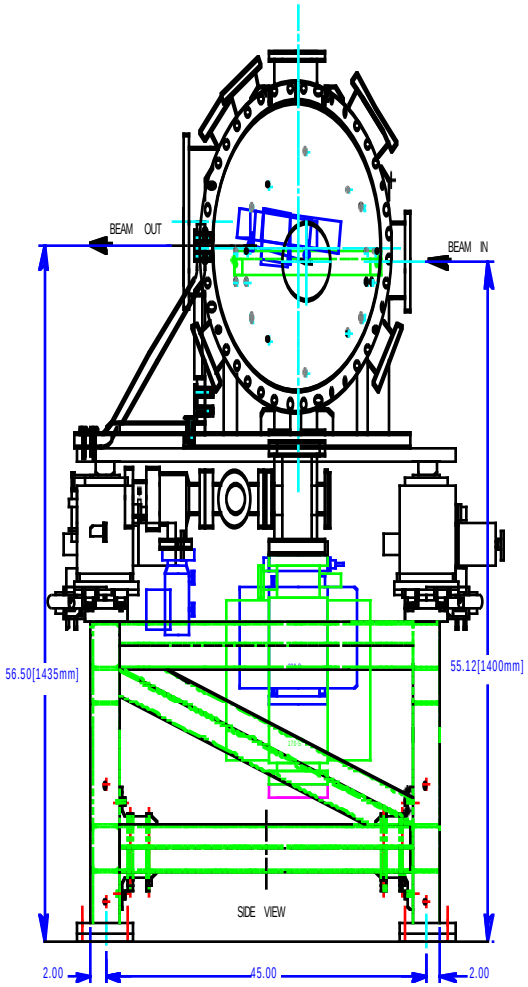

Figure 9 A front view of the BESSRC monochromator mounted on a kinematics table. The 170 and 220 l/sec. ion pumps are used on the rotary drive and monochromator chambers respectively. The monochromator chamber ion pump also has a NEG insert for additional pumping.

Table 3 Vacuum, Type of Radiation, PSS, and EPS Status for 12-BM Components.

Part#	Description	Vac. Status	PSS* Status	EPS Status **				Comments
				Water flow	Posit-ion	Vac.	Temp	
12BM 11	Front End Be Window	UHV *		Y		Y	Y	APS
12BM 12	F.E. Welded Bellows	UHV						start of BESSRC components
12BM 14	Unshielded 6" Pipe	UHV						custom length
12BM 18	F2-20 Filter	UHV		Y	Y	Y	Y	STD Component, EPS Control
12BM 19	L3-20 Slits	UHV		Y	Y	Y	Y	STD Component
12BM 22	Collimator, K2	UHV	A					Part of Bremm. Shielding
12BM 23	Formed Bellows	UHV						
12BM 24	Transport Pipe	UHV						
12BM 26	Transport Pipe	UHV						
12BM 29	Gate Valve	UHV			Y			Position controlled by EPS
12BM 30	Formed Bellows	UHV						
12BM 34	Adapter Pipe	UHV						
12BM 35	BESSRC Mono	HV		Y	N	Y	Y	
12BM 40	Adapter Pipe	HV						
12BM 41	Formed Bellows	HV						
12BM 42	Gate Valve	HV			Y			Position controlled by EPS
12BM 43	Transport Pipe	HV						
12BM 46	Formed Bellows	HV						
12BM 50	P6-20 Shutter	HV	M/I	Y		Y	Y	APS STD Component

* PSS Status Indicator: I-interlocked, A-administratively controlled, M-mode controlled

** EPS Status Indicator: Y-yes, N-no, X-not applicable

Table 3 (continued)

Part#	Description	Vac. Status	PSS Status	EPS Status				Comments
				Water flow	Posit-ion	Vac.	Temp	
12BM 54	Collimator, K2	HV	A					Part of Bremm. Shielding
12BM 55	Gate Valve	HV			Y			Position Controlled by EPS
12BM 56	V2-91 Bellows	HV						End of FOE
12BM 57	Shielded Pipe	HV	A					
12BM 62	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 64	Shielded Pipe	HV	A					
12BM 65	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 67	Shielded Pipe	HV	A					
12BM 68	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 70	Shielded Pipe	HV	A					
12BM 74	Adapter Flange	HV						Inside Shielded Enclosure
12BM 75	Ion Pump, 120 l/s	HV				Y		Inside Shielded Enclosure
12BM 77	G1-81Screen Assembly	HV						Inside Shielded Enclosure
12BM 78	Gate Valve	HV			Y			Controlled by EPS
12BM 79	U1-56 Bellows	HV						Inside Shielded Enclosure
12BM 81	Shielded Pipe	HV	A					
12BM 85	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 87	Shielded Pipe	HV	A					
12BM 88	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 90	Shielded Pipe	HV	A					
12BM 94	Adapter Flange	HV						Inside Shielded Enclosure
12BM 95	Ion Pump, 120 l/s	HV				Y		Inside Shielded Enclosure
12BM 97	6-Way Cross	HV						Inside Shielded Enclosure

Table 3 (continued)

Part#	Description	Vac. Status	PSS Status	EPS Status				Comments
				Water flow	Posit-ion	Vac.	Temp	
12BM 99	V2-91 Bellows	HV						Inside Shielded Enclosure
12BM 101	Shielded Pipe	HV	A					
12BM 105	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 107	Shielded Pipe	HV	A					
12BM 108	U1-57 Bellows	HV						Inside Shielded Enclosure
12BM 110	Shielded Pipe	HV	A					
12BM 114	U1-56 Bellows	HV						Inside Shielded Enclosure
12BM 116	Gate Valve	HV			Y			controlled by EPS
12BM 117	L4-20 Slits	HV				Y		APS STD Component
12BM 118	In-Line Pump, 120l/s	HV				Y		Inside Shielded Enclosure
12BM 119	U1-56M Bellows	HV						"
12BM 120	Beam Profile Monitor, 6-Way Cross	HV						"
12BM 122	U1-56M Bellows	HV						"
12BM 123	6" Transport Pipe	HV						Inside Shielded Enclosure
12BM 129	W4-20 Be Window	HV		Y			Y	Inside 12-BM-B Hutch

Vacuum Status

The 12-BM beamline is designed to be in compliance with the APS Vacuum Policy (Oct., 1994). Table 3 gives the Vacuum status for each component in the 12-BM beamline. This table uses the definitions of vacuum status which are described in the APS vacuum policy: vacuum trips are set at 1×10^{-8} Torr for UHV, 1×10^{-6} Torr for HV, 1×10^{-3} Torr for MHV.

Schedule

Installation Schedule

The installation schedule for the 12-BM beamline are given in Appendix C.

Procurement Schedule

The projected delivery dates for all standard components is available from the APS staff. Since these components are purchased through the APS this listing is maintained by APS staff. Component installation dates as given in Appendix C may vary as the procurement schedule is updated. The non-standard components, i.e. the BESSRC monochromator and monochromator support table are already on site.

APS Support Schedules

Utility Installation

Utilities will be installed on the 12-BM beamline as the enclosures are constructed. The utilities in the 12-BM-A enclosure are already installed. The installation of the remaining utilities will require the construction of the 12-BM-B enclosure for the first phase of installation and the 12-ID mono/pink beam enclosures for the final stage of installation. Construction of the 12-BM-B enclosure is expected in Feb. of 1996 so that the first stage of utilities installation should be possible at that time. There is not presently an estimate of the construction schedule for the 12-ID enclosures so that a complete utilities construction schedule will be given with the 12-ID FDR.

Survey & Alignment

The schedules for survey and alignment by the APS Survey and Alignment Group are given in Table 4. These schedules are based on the predicted delivery dates of major components and therefore may change if delivery dates are not met.

PSS Installation and Checkout Schedule

PSS installation for the 12-BM-A enclosure is presently underway. Installation of the PSS hardware along the beamline and on the 12-BM-B enclosure will be required soon after the 12-BM-B enclosure is finished. Construction of this component is to take place in Feb. of 1996 so that the PSS raceway and Hutch should be in place during March. Installation of the PSS hardware, wiring and checkout should be done to allow a May 1 commissioning of the 12-BM-B enclosure and beamline.

Table 4 12-BM Survey and Alignment Schedule

Component	Part #	Projected Survey Date
Collimator	K2-22	12/95*
White Light BM Filter Assembly	F2-20	12/95
White Light BM Slit Assembly	L3-20	12/95
Collimator	K2-22	12/95
BM Shutter/ White Beam Stop	P6-20	12/95

* Installed as part of the 12-BM commissioning. Parts to be moved to final positions 4/96.

Safety

Personnel Safety System(PSS)

Interlocked Components

The components which are interlocked as part of the PSS system are given in Tables 3 and 5. The designations "**I"** imply an interlocked control procedure, "**A"** means a Administratively controlled component and "**M"** stands for a mode Controlled (Kirk Key) controlled device.

Table 5 Identification of Interlocked Components.

Component	Part #	PSS Status
12-BM-A Enclosure		I
White Beam Stop / Monochromatic Shutter	P6-20	I M
12-BM-B Enclosure		I

Administratively Controlled Components

Those components where access will be controlled by administrative means include the shielded pipe stands, small shielded pump enclosures located in the transport section of the beamline and the enclosure for the L4-20 Slits locate immediately in front of the 12-BM-B enclosure. The method by which these enclosures will be secured and type of controls to be used will be discussed with the APS staff and will be part of the beamline commissioning documentation.

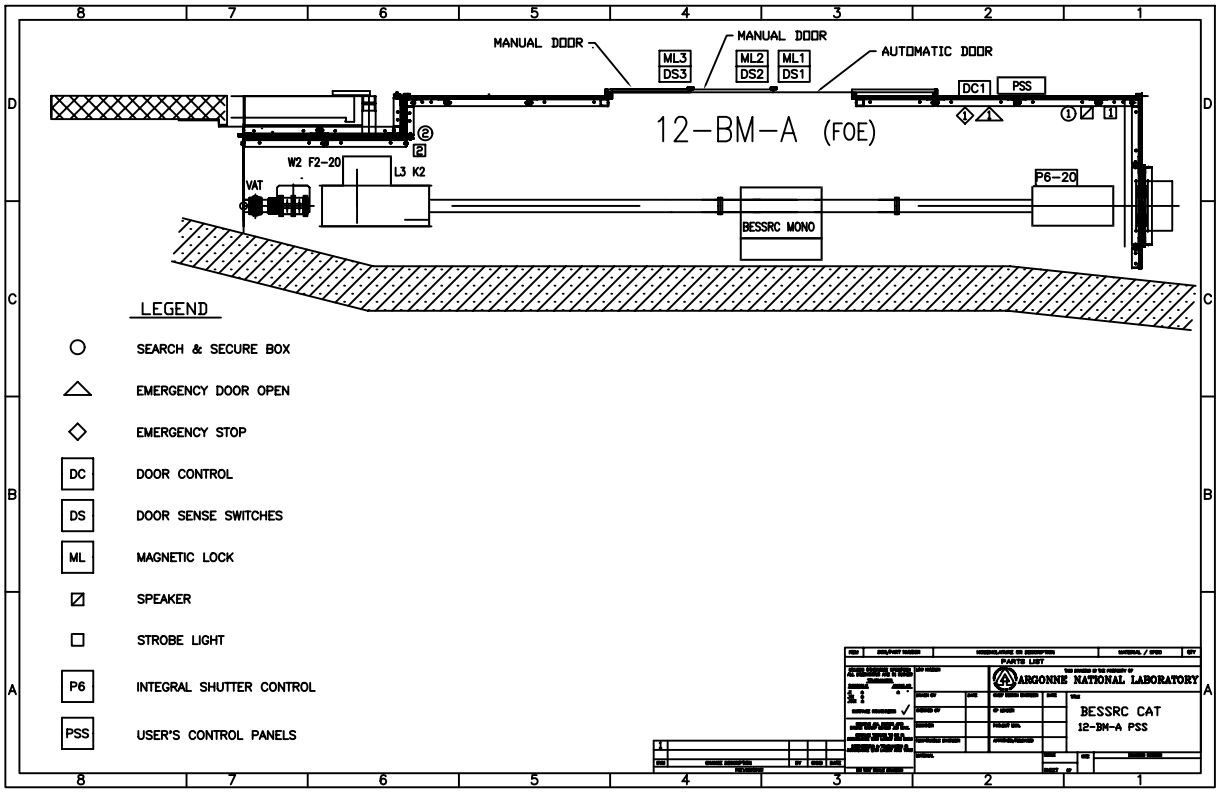

Figure 10 PSS component locations in the 12-BM-A (FOE) enclosure.

Location of PSS Hardware

Details of PSS hardware locations for the FOE are given in Fig. 10 and for the 12-BM-B enclosure in Fig. 11.

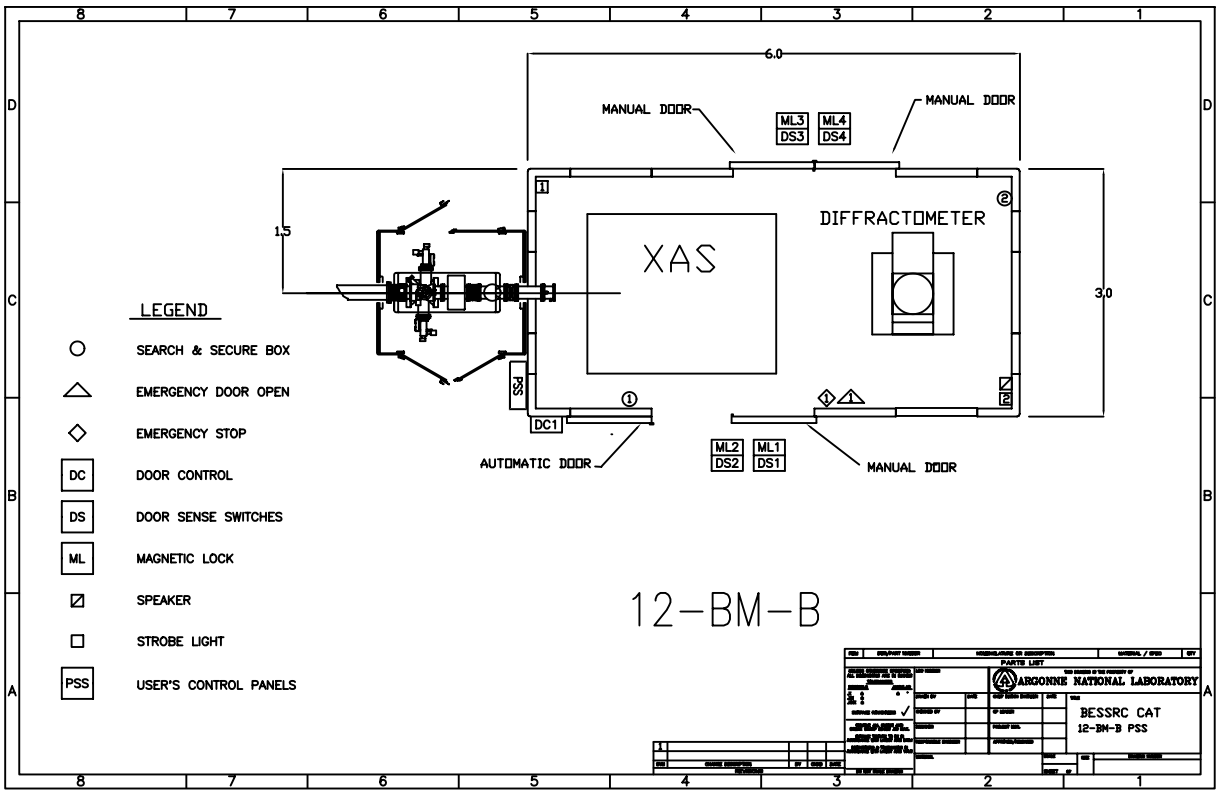

Figure 11 PSS component locations in the 12-BM-B enclosure.

Beamline Mode Logic

Table 6 provides the PSS logic for the different modes of operation for the 12-BM beamline. The first column in the table shows a beamline mode and each of the succeeding columns shows the status of a particular component for that given mode. The positions of the P6-20 Photon Stop and P6-20 Bremstralung Stop are to be changed by switching Kirk keys between the shutter assembly and a control panel. Table 6 also gives the logic diagrams for the 12-BM beamline after the installation of a mirror in the FOE.

Table 6 PSS Logic for different modes of operation.

Component Status Beamline Mode (Phase 1 - no Mirror)	P6-20 Photon Stop In	P6 Brems. Stop In	P6 Mono Shutter In (Closed)
12-BM-A (FOE) Online	T	T	T
12-BM-A and Mono Beam in 12-BM-B Online	T	T	F
Beamline Mode (Phase 2 - Mirror in line)			
12-BM-A Online	T	T	T
12-BM-A and Mono Beam in 12-BM-B Online	T	T	F
12-BM-A and Pink Beam in 12-BM-B Online	F	F	F (locked)
T-True, F-False, X-Component Status does not affect beam			

Experimental Station Logic

Tables 7 and 8 give the PSS logic for the 12-BM-A and 12-BM-B experimental stations. The format is the same as that given in the SRI CAT Sector 1 FDR; i.e. the first column in the table gives the desired beamline status and the subsequent columns show the states of the components required to produce that status. In Phase 1 of beamline operation (that is without a mirror) and in Phase 2 (with a mirror) the five possible user actions are identical. These are:

1. Bring beam into the 12-BM-A enclosure.
2. Bring beam into the 12-BM-A enclosure and the 12-BM-B enclosure.
3. Bring beam into the 12-BM-B enclosure when it is already entering the 12-BM-A enclosure.
4. Enter the 12-BM-B enclosure.
5. Enter the 12-BM-A enclosure.

Table 7 gives the status of components required for monochromatic beamline operation (Phase 1 & Phase 2) while Table 8 gives the states of components and subcomponents for pink beam operation (Phase 2).

Table 7 PSS Logic for Monochromatic operation.

Component Status Beamline Status	12-BM-A Enclosure Secure	12-BM-B Enclosure Secure	Front End Shutter Closed	P6-20 Photon Stop In	P6 Brems. Stop In	P6 Mono Shutter In (Closed)
Beam into 12-BM-A	T	X	O T⇒F	T/M	T/M	T
Beam into 12-BM-B	T	T	O T⇒F	T/M	T/M	O T⇒F
Beam into 12-BM-B when in 12-BM-A	T	T	F	T/M	T/M	O T⇒F
Access to 12-BM-A	O	X	T	X/M	X/M	T
Access to 12-BM-B, with 12-BM-A not Secure, #1	F	O	T	X/M	X/M	T
Access to 12-BM-B, with 12-BM-A Secure, #2	T	O	X	T/M	T/M	O F⇒T

T-True, F-False, O- Component which is changing state, X-Component Status does not affect beam, T⇒F means the component changes state so that the Status changes from True to False

Table 8 PSS Logic for Pink Beam operation (mirror in place, Phase 2)

Component Status Beamline Status	12-BM-A Enclosure Secure	12-BM-B Enclosure Secure	Front End Shutter Closed	P6-20 Photon Stop In	P6 Brems. Stop In	P6 Mono Shutter In (Closed)
Beam into 12-BM-A	T	X	O T⇒F	T	T	X/M
Pink Beam into 12-BM-B	T	T	O T⇒F	O T⇒F	O T⇒F	X/M
Pink Beam into 12-BM-B when in 12-BM-A	T	T	F	O T⇒F	O T⇒F	X/M
Access to 12-BM-A	O	X	T	X	X	X/M
Access to 12-BM-B, with 12-BM-A not Secure, #1	F	O	T	X	X	X/M
Access to 12-BM-B, with 12-BM-A Secure, #2	T	O	X	O F⇒T	O F⇒T	X/M
T-True, F-False, O- Component which is changing state, X-Component Status does not affect beam, T⇒F means the component changes state so that the Status changes from True to False						

Equipment Protection System (EPS)

The primary purpose of the beamline Equipment Protection System (EPS) is to ensure that beamline components are protected from beam related damage. To perform this function, the beamline EPS monitors parameters such as water (flow, pressure, and temperature), beamline vacuum levels and critical components (position, temperature, and operational mode) at key points along the beamline. If and when a parameter falls outside of its preset operating range, an interlock trip will result and a shutter and/or valve located upstream of the fault will be closed. For white-beam components, this fault is communicated to the front-end EPS, which signals the Personnel Safety System (PSS) to close the front-end safety shutters. For faults effecting other beamline components, the shutter to be closed is specified as part of the beamline EPS logic. Beamline vacuum faults will signal the EPS to isolate beamline segments by closing the appropriate pneumatically activated VAT valves.

The EPS logic will be implemented using Koyo Programmable Logic Controllers (PLCs). The inputs to the PLCs (logical and otherwise) will come from the PSS, the front

end EPS, EPS control panels and from parameters measured along the beamline. Signals from the beamline are channeled directly into Koyo I/O terminal blocks (for analog, DC, and thermocouple input) or initially to process controllers which are then read out by the PLCs. The logical outputs from the PLCs are communicated to the front end EPS, to the beamline VAT valves, and to EPS control/display panels located on the beamline.

Each of the parameters (e.g., temperature, flow, pressure) to be monitored along the beamline is measured by a Koyo DL405 CPU PLC connected to the various I/O blocks. When parameters falls outside their set points (as defined in the beamline EPS logic), the PLCs communicate an open contact to the PSS and front end EPS. The current state of the PLCs will also be updated on the EPS control/display panel. Additionally, the value of each parameter can be read by a beamline computer by direct communication with the PLC through a dedicated serial line. These parameters can then be stored in soft records in a beamline VME crate via EPICS Channel Access (CA) after which they may be manipulated as normal EPICS process variables. Table 4 indicates which components are monitored by the EPS. The general type of monitoring is shown (coolant, temperature, vacuum, or position), along with special considerations (shown in the comments). In addition, on ID beamlines, the ID gap and storage-ring current are monitored and used to determine which configurations of the user filters are permissible and to prevent operation if these conditions are not met.

The EPS hardware will be located in racks outside the 12-BM-A and 12-BM-B enclosures. Rack mounted Koyo PLCs, I/O bricks, block I/O modules, and the EPS status and control panels as well as any specialized process controllers will be located close to the egress points of the enclosures. .

Beamline Shielding

The shielding for the 12-BM experimental stations and transport sections meets all requirements set forth in ANL/APS/TB-7 and subsequent ANL/XFD Radiation Safety documents.

Ozone Mitigation Procedures

The calculations of ozone production rates from monochromatic or pink beam done for the BESSRC CAT PDR showed that ozone concentrations will be negligible in all the BESSRC experimental stations. This is particularly true for the operational modes of the 12-BM beamline since no white beam will be used outside a vacuum enclosure. If ozone

appears to be a problem in bending magnet beamlines commissioned before the 12-BM line mitigation procedures will be implemented during beamline commissioning.

Safety Hazards

Chemical and electrical safety hazards in the 12-BM experimental stations, on the beamline and in the BESSRC CAT LOM were previously discussed in the preliminary BESSRC CAT Safety Plan and will be readdressed in the final BESSRC CAT Safety documents.

Fire Safety

The designs for the 12-BM enclosures and transport do not include significant fire hazards. The policies and procedures for accessing and mitigating any fire hazard on the 12-BM beamline will be addressed in the final BESSRC CAT Safety documents.

Special Operations Requirements

Present plans call for no special operational requirements for the 12-BM beamline.

Appendix A

List of beamline Drawings

Figure 1 12-BM Beamline Drawing

12BMVIEW.DWG *

Figure 2 Sector 12 Drawing

SECT12.DWG *

Figure 3 12-BM-A FOE Drawings

A. FOE Drawings, top and side views.

VG12BM-F.DWG

Detailed drawings for the 12-BM-A experimental station are

HI2100-9 thru HI2100K*

A22843-1 thru A22843-9*

A2284310*

A2284311*

Figure 4 12-BM Transport Section Drawing

VG12BM-T.DWG*

Figure 5 12-BM-B Experimental Station Drawings

A. Top and side views

VG12BM-H.DWG*

Detailed drawings for the 12-BM-B experimental station are

H17900-1 thru H17900-9*

* Drawings in BESSRC CAT Beamline Review Library on the APS Design Exchange.

Figure 6 Sector 12 Utilities Layout Drawings

Cable Trays	12TRAYVW.DWG
Electrical Power	12DUCTVW.DWG
Water	12WATRVW.DWG
Air	12AIRVW.DWG

Figure 7

A. Horizontal Ray tracing for the 12-BM beamline
B. Vertical Ray tracing, monochromator only
C. Vertical Ray tracing, mirror only
D. Vertical Ray tracing, monochromator and mirror

Figure 8 Monochromator Chamber

MONOCHMB.DWG*

Figure 9 Monochromator Table

T63200-A.DWG*
T63200-B.DWG*
T6320101.DWG*

Figure 10 PSS component locations in the 12-BM-A (FOE) enclosure

PSS12BA.DWG

Figure 11 PSS component locations in the 12-BM-B (FOE) enclosure

PSS12BMB.DWG*

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* Drawings in BESSRC CAT Beamline Review Library on the APS Design Exchange.

* Drawings in BESSRC CAT Beamline Review Library on the APS Design Exchange.

* Drawings in BESSRC CAT Beamline Review Library on the APS Design Exchange.

* Drawings in BESSRC CAT Beamline Review Library on the APS Design Exchange.

** Drawings in the General Library on the APS Design Exchange.

Appendix B

List of Components

Appendix C

Construction Schedule